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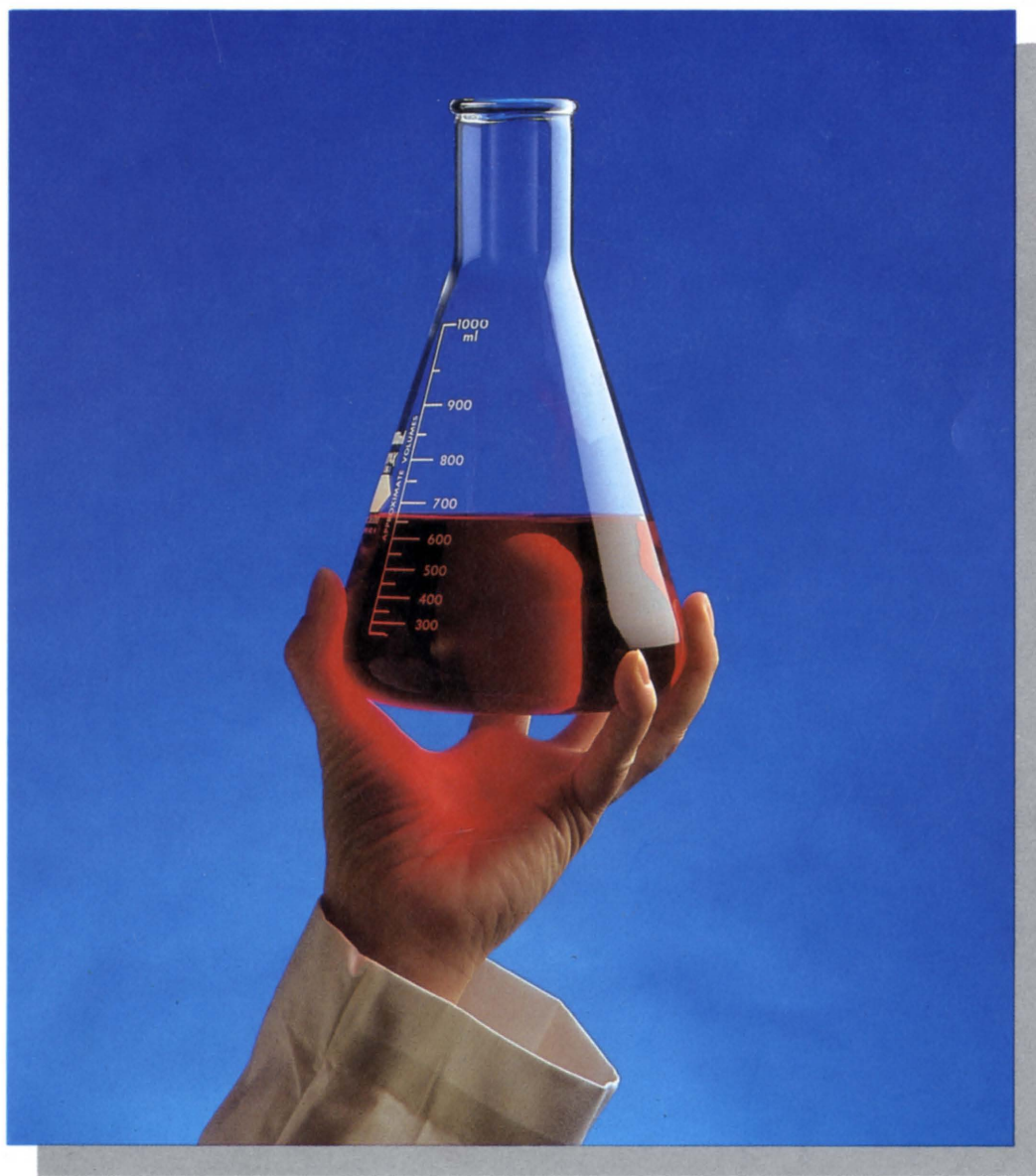
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UTAH SCIENCE

UTAH STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION VOLUME 53 WINTER 1992 NUMBER 4



Centers of Excellence

UTAH SCIENCE

UTAH AGRICULTURAL EXPERIMENT STATION
UTAH STATE UNIVERSITY
LOGAN, UTAH 84322-4845

Paul S. Smissen DIRECTOR

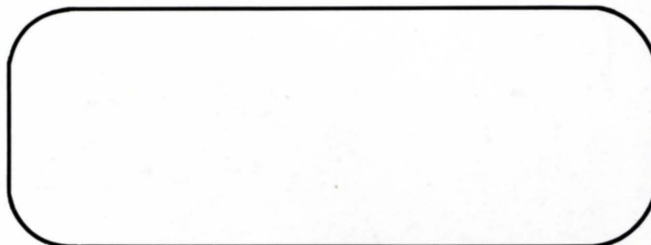
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About this issue...

Excellence.

It's a word that's often mouthed and a concept that's seldom achieved. It's on every politician's agenda.

Widespread use may trivialize the meaning of the word, but no such diminution has occurred at USU.

Several years ago, the State of Utah initiated a Centers of Excellence Program, which is designed to accelerate the flow of technology from universities to business and industry. The State provided seed money, the universities conducted the research and the resulting innovations spurred job creation and economic growth.

It is an excellent idea.

So far, Utah's program has been remarkably successful and has been a model for similar programs in several other states. The Centers have underscored the synergism between education, research and economic growth.

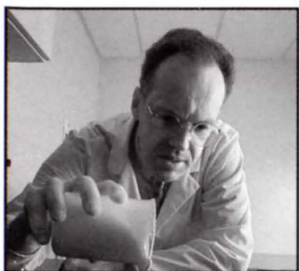
This issue focuses on three USU Centers of Excellence at USU that directly concern agriculture. Like every other aspect of society, agriculture's future hinges on the pursuit of excellence. The Centers are one means of doing so.

The sidebars in this issue feature projects that are supported in part by federal mineral lease funds. Mineral lease funds compensate counties for non-taxable federal lands, and are earmarked for projects that will help areas overcome the loss of taxes from a potentially significant tax base.

The benefits of some projects will be realized in a few years. Other research promises long-term gains. All help utilize the state's abundant human and natural resources to sustain economic growth.

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Trimming the Meekness from Red Meat Marketing

After years of watching from the sidelines, the red meat industry is starting to play chicken—and with a vengeance.

“The red meat industry mistakenly assumed that Americans would always prefer steaks, chops and other traditional cuts,” says USU food scientist Von Mendenhall, director of the Center for Meat Processing Technologies. Not so. While our per capita consumption of red meat is still among the highest in the world, Americans’ loyalty to beef, pork and lamb has been more fickle than the industry assumed.

Concerns about health and diet (some of them the offspring of fads and foibles) prompted much of the decline, but credit the poultry industry for aggressively wooing customers by purveying chicken in nearly every conceivable shape and size, and to fit every taste.

Photo: Von Mendenhall

HEFTIER CALVES MEAN FATTER PAYCHECKS

These are *some* calves.

They're big—weaning weights can top 1,200 pounds. And they're good. The succulent low-fat, low-cholesterol beef they produce has earned rave reviews in taste-panel tests.

Marketing calves at heavy weaning weights could be a mighty profitable option for some ranchers in Utah, particularly if grazing rights on public lands are curtailed, forcing ranchers to rely on feedstuffs from private land, says USU animal scientist Randy Wiedmeier.

Several months ago, Wiedmeier wondered whether genetic improvement made it feasible to wean calves at slaughter weights. If so, ranchers could markedly cut feed costs—it costs much less to maintain one cow that weans a 1,200-pound calf than to maintain two cows that wean 600-pound calves. There would be other savings as well.

Last year, Wiedmeier proved that it's possible. Two of three calves sired by a superior bull reached slaughter weights when they were weaned. One calf weighed 1,193 pounds at 270 days and produced a 719-pound carcass that graded high select. "You couldn't ask for anything better," Wiedmeier says.

Many range calves are now sold out of state, and may be purchased four times before they reach slaughter weight. "There's usually a 3 or 4 percent commission every time a calf changes hands, which cow-calf producers ultimately pay for," Wiedmeier says. Weaning slaughter weight calves would let Utah ranchers capture these commissions.

"The way we have it figured, producers weaning slaughter weight calves could make \$400 per calf instead of the \$100 or less they now earn by selling lighter calves," Wiedmeier says.

Creep feeding—providing supplemental grain—complements calves' genetic ability. Calves went on creep feed at 150 days and gained weight rapidly and efficiently. They required only 3 pounds of creep feed per pound of gain, much less than the 8 or 9 pounds of feed per pound of gain that calves usually require after they're weaned. Some calves gained almost 5 pounds daily.

"There's no doubt in my mind that it can be done," Wiedmeier says. "The real problem is that cow-calf producers don't believe it can be done, although I admit that even we were somewhat surprised by the results."

KG Randall Wiedmeier

"It will take us 5 or 10 years to catch up to the poultry industry," Mendenhall says. However, the center is already off to a good start with products such as stew on a stick, low-fat lamb chops and franks, and packaging that preserves meat's freshness and trims waste.

Utah farmers, who derive about three-quarters of their income from livestock, will find more on their plates if any of these new products become *haute cuisine*.

Mendenhall closely monitors the pulse of consumer preferences. Fat and cholesterol are out, convenience is essential. Add taste, texture, eye appeal, processing costs and retail price to the equation. Consumers seem to be more responsive to a food's nutritional merits, even though impartial information is often garbled by advertising claims and is sometimes distorted by bogus claims—or accusations.

The low-fat, boneless lamb chop developed at the center is now produced by Timpanogos Meat in Springville. Sierra Lamb Chops contain less than 4 grams of fat per serving, much less than the 22 grams of fat in a single serving of choice lamb.

DIFFERENT BOUNDARIES FOR MORE ACCURATE CLIMATE RECORDS

In 1957, the National Weather Service divided Utah into seven climatic divisions, which the Utah Climate Center has used in its reports. It's time to change these divisions, says Donald Jensen, director of the center.

For example, the state's Western division stretches from the Idaho border on the north almost to St. George on the south. Utahns know that weather conditions in the south can be much different from those in the north.

The Climate Center staff is using weather information from 14 data bases, including records from the Bureau of Land Management, the Soil Conservation Service, the National Weather Service and the Bureau of Reclamation, to redraw the divisions.

This information is used for a variety of purposes, including predicting plant growth and development, in pest control, identifying areas prone to drought and flooding and designing irrigation schedules. "Looking at weather over big, broad areas doesn't help very much," Jensen says. Changing the climate divisions will markedly improve the accuracy and utility of the information.

LH

Donald Jensen
750-2191

The chops contain a variety of cuts, including some that aren't too popular in their unprocessed form. Fat is removed and replaced with water (to prevent dryness), and phosphates and salt are added. The meat is tenderized by massaging it with by rollers. Tiny knives macerate muscle fibers to make biting easy. The meat is then formed into a loin, cut into chops and vacuum sealed.

Food service managers especially like the ability to control portion size.

Reducing fat content also eliminates most of the strong "lamb" flavor that many American consumers find objectionable (consumers in many other countries relish the taste, however). Some older Americans developed an aversion to this flavor from strongly flavored, greasy mutton from Australia during World War II.

Removing fat is only a partial solution. It would be better if lambs were leaner, a step that would also cut production expenses. This may be possible if animal geneticist Noelle Cockett and embryologist Kenneth White can locate the genetic markers associated with leanness, thus making it possible to breed sheep for this trait.

Researchers were particularly interested in low-fat products based on lamb, which contains the most saturated fat of the red meats, but low-fat products based on other types of meat are also being developed.

BETTER TREATMENT FOR A POULTRY DISEASE

U.S. poultry producers lose more than \$300 million annually to avian coccidiosis, a parasitic infection. A major cause of avian coccidiosis is *Eimeria tenella*, a protozoan parasite that infects the blind pouches (ceca) of the small intestine of chickens. Mortality in infected flocks may reach 20 percent.

It's not practical to totally eradicate the disease, so producers have relied on nutrition, sanitation and drugs to control it. Vaccination is a particularly promising option.

Veterinary scientist Mark Healey is developing a subunit vaccine against the sexual stages (gamonts) of *E. tenella*. His laboratory is identifying the protective antigens on the surface of gamonts. These antigens can then be incorporated in a vaccine, thus reducing tissue damage in infected chickens and preventing spread of the disease.

KG Mark Healey 750-1901

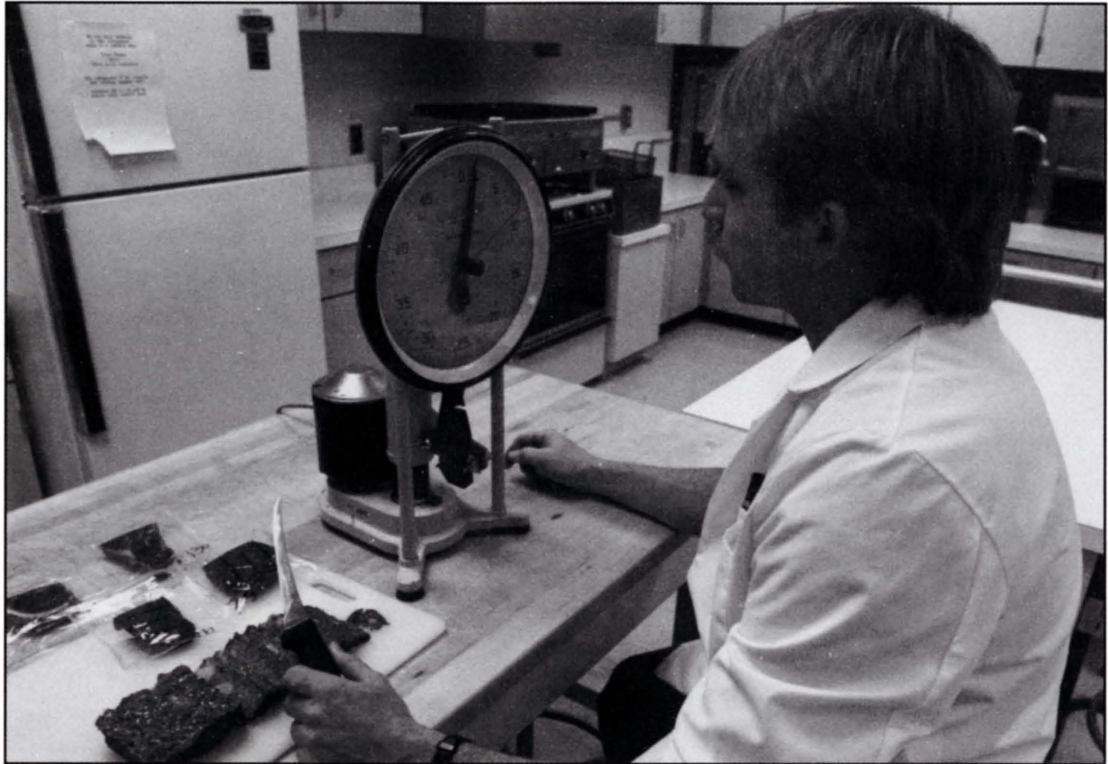
There's a processed pork chop (just 4 grams of fat) and a low-fat pork chop flavored with sausage seasonings for people on fat-restricted diets. The processes used to make low-fat lamb chops could also transform lean cuts of beef, many of which are tough, into flavorful, palatable steaks.

Lean pork made into a jerky-like pork stick is more moist than traditional jerky. Food technologist Daren Cornforth added various vegetables, which reduces the stick's fat content and increases its fiber content and nutritional value. Likely customers for this "stew-on-a-stick" include outdoor sports enthusiasts, who need substantial, nutritionally complete snacks. The sticks could be an alternative use for older pigs that are now only used for sausage.

Also on tap is a beef steak that can be cooked in a microwave oven in less than 2 minutes. (Mendenhall won't say much about the process since it has not been patented yet.) Nutritional scientist Charles Carpenter is concocting a low-fat frankfurter that contains 5 percent fat, substantially less than the 30 percent fat of some conventional franks, and products made from spent laying hens, whose tough strongly flavored meat has largely been used in soups or gravies where strong flavor is a plus.

"Several egg producers in Utah produce a lot of spent hens every year and no processing plant in the state uses the meat," Mendenhall says. "We are looking for ways that Utah businesses can use these hens."

The center studies packaging technology, including some that could extend the refrigerated shelf life of meat from the conventional two days to 21 days. One technique, gas flushing, replaces oxygen in the package with carbon dioxide and nitrogen, two inert gases that prevent the growth of microorganisms.



Graduate student Dave Rawlings uses a device to test the tenderness of meat.

Researchers are also studying a clear, tasteless, edible film recently developed at the Western Dairy Research Center at USU. The film prevents the oxidation of meat, thus improving the appearance and extending the shelf life of precooked meats.

"Many meats, especially pork, oxidize too fast to be used in the deli case. This film can't be seen, tasted or felt," Mendenhall says. In addition to reducing waste, the film could increase the popularity of meats that otherwise don't store well.

Irradiation promises to improve the shelf life of beef-based products. Irradiation (it's *not* radiation) has been approved for pork, poultry, and many fruits and vegetables, and will probably be approved for beef within a year.

In spite of these advances, one big hurdle still remains—the reluctance to combine meat from various species, not only to produce products with a host of unique

TRACKING DOWN SOURCES OF NONPOINT SOURCE POLLUTION

When high levels of pollutants are detected in the Little Bear River, agriculture usually gets most of the blame.

The river starts in the mountains and often traverses farmland, which means that agriculture can certainly contribute to nonpoint source pollution. However, agricultural engineer and water quality specialist Kitt Farrell-Poe thinks there are probably other causes as well.

To find out, she selected streams that pass through Paradise, Mendon, Hyrum and Smithfield and will sample the water upstream and downstream from each town to determine what chemicals, sediment, bacteria and other pollutants are added during water's trip through town.

Possible nonagricultural culprits include overfertilization and overirrigation of lawns, and the practice of washing driveways and sidewalks.

LH Kitt Farrell-Poe
750-3389

attributes but—heaven forbid—products that taste like another species. One example—combining lamb and turkey to produce something that tastes like beef, a product that USU researchers have already concocted.

HELPING FARMERS PLAN

Farming is a business, one with thin profit margins and generous uncertainty.

USU economists Don Snyder and Larry Bond are helping bolster the former and reduce the latter by preparing detailed enterprise budgets. The budgets show the profitability of various agricultural enterprises, including the production of onions, alfalfa, barley, wheat and beef.

They recently standardized the format of the budgets, which makes it easier to analyze additional enterprises. And upon request they will send a computer disk that lets farmers conduct their own analyses.

Mineral Lease Funds and the Utah Department of Agriculture support the preparation of the enterprise budgets.

KG Larry Bond 750-2320
Don Snyder 750-2305

"Meat protein is meat protein, regardless of the source," Mendenhall says bravely, although his ersatz beef steak still remains only a creature of the laboratory. "It was nearly indistinguishable from beef steak."

Mendenhall says the United States lags behind Germany and Japan in the development of new processes and processing equipment. "But equipment isn't the biggest barrier to the development of new products. The largest impediment has been the lack of new ideas."

Not any more. A lamb-turkey beefsteak and stew on a stick certainly aren't the products of feeble imaginations.

LH Von Mendenhall 750-3463



Richard Wang

Taming Apomixis to Create New Wheat Hybrids

Nature thrives on randomness and diversity, much of it the aftermath of sexual reproduction. For whatever reasons, nature has developed some reproductive methods that foster uniformity rather than heterogeneity. One of these methods is apomixis, which 300 or so species of plants use to sidestep sexual reproduction, thereby letting them clone themselves.

This asexual method of cloning may be used to create new hybrids in crops where conventional methods of producing hybrids are now difficult and expensive. Shuttling the genes that control apomixis from wild plants to these crops would make it possible to clone hybrids, thus avoiding the need to produce hybrid seeds annually, a costly procedure that requires special hybridization fields.

Wheat, cotton and rice are some of the crops that are candidates for apomixis. USU researchers with the Center for Value Added Seed Technology are trying to transfer the apomixis genes to wheat, a prelude to wheat hybrids that promise to increase yields by 10 to 15 percent. The transfer could make hybrid wheat as common as hybrid corn, which has replaced nearly all open-pollinated varieties in the U.S. since its introduction a half century ago.

NUTRITIONAL ASSISTANCE FOR THE ELDERLY

Retirement, graying hair and wrinkles. All tend to happen when we age.

Add malnutrition to the list.

Many older Utahns rely on meals at senior citizens centers and in-home meal programs like Meals on Wheels, but the demand for programs such as these is expected to increase dramatically. (The number of people 65 and older in the state is expected to increase by more than 50 percent in the next eight years.)

Can these programs keep pace? Carol T. Windham and Georgia C. Lauritzen in the USU Department of Nutrition and Food Sciences are trying to find out.

In addition to predicting demand for these services, they are identifying the proportion of elderly that appear to be at nutritional risk.

Windham says several factors interfere with good nutrition among the elderly. Many people can't afford food. Some lose interest in preparing food when they have to eat alone. Medication can interfere with nutrient utilization or can ruin appetites.

The findings will help agencies plan cost-effective assistance. The research is partially funded by Cooperative Extension Service and Extension home economists throughout the state will use the results in their programs.

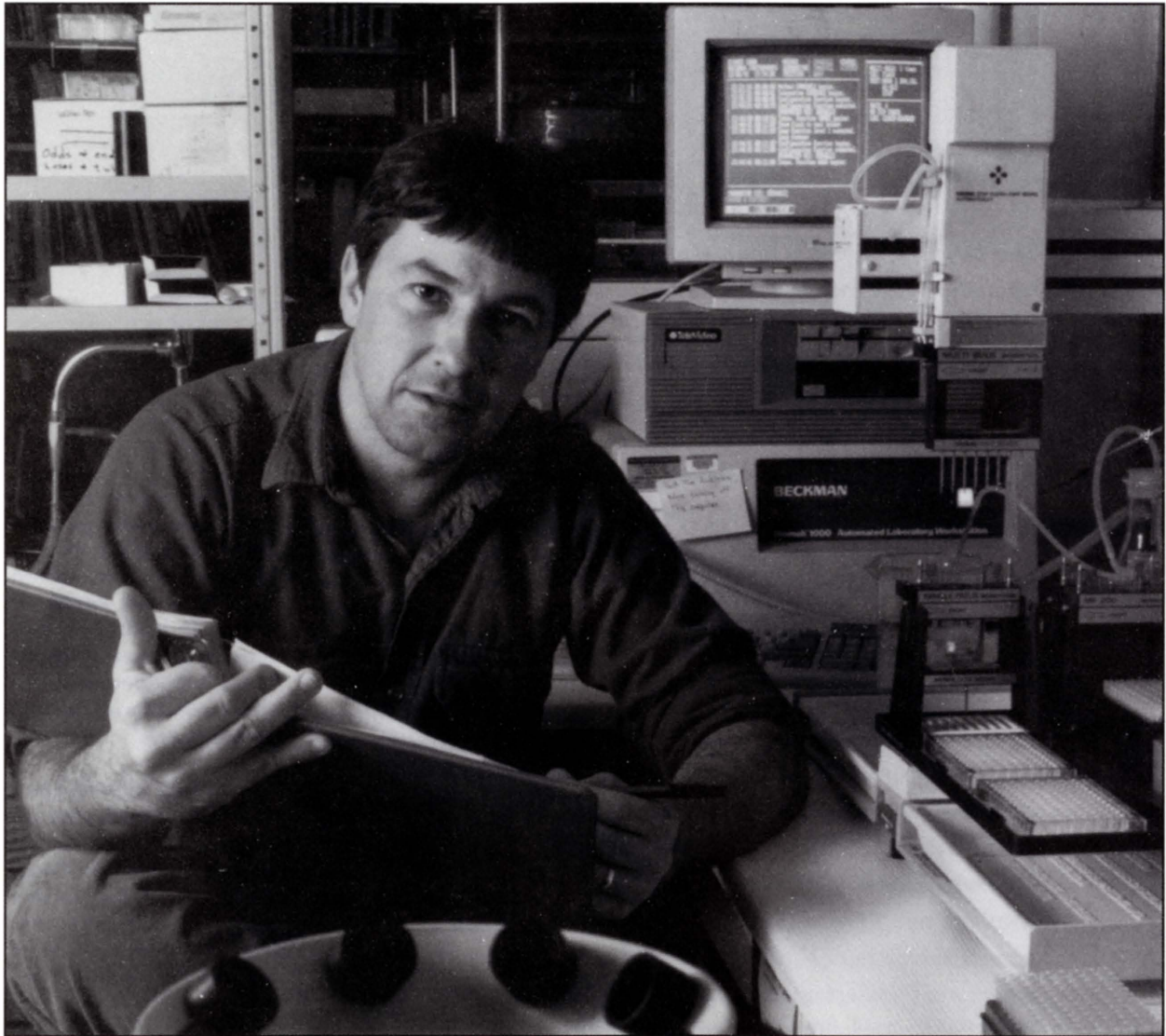
LH Georgia Lauritzen
750-3464
Carol Windham
750-2121

The potential payoff is huge. Unfortunately, so are the obstacles.

One breakthrough occurred when USU plant scientist John Carman identified and characterized apomixis in Australian wheatgrass, a distant relative of wheat, and collected seed from more than 200 species in Australia and New Zealand. His early attempts to hybridize Australian wheatgrass with wheat were unsuccessful, however.

A Canadian researcher successfully crossed wheat with Australian wheatgrass, but a sexual strain of Australian wheatgrass was used and the resulting hybrid lacked the apomixis gene. (Researchers learned that only some strains of Australian wheatgrass possess apomixis.) Richard Wang, plant geneticist with the USDA Agricultural Research Service's Forage and Range Research Laboratory was the first to produce an apomictic wheat-wheatgrass hybrid, an important step in the development of self-cloning wheat hybrids.

"The task is more complicated than we originally thought. We don't yet even know how many genes are involved with apomixis," Wang says.



John Carman

Researchers are now trying to locate the genes that control apomixis in Australian wheatgrass. The search, which involves both wheat-wheatgrass hybrids and crosses between sexual and apomictic strains of Australian wheatgrass, is hampered by high mortality in the wheatgrass-wheat progeny and the furtiveness of the trait.

DECIPHERING GRAZING PREFERENCES

What determines where livestock graze?

The answer isn't as obvious as it seems. Certainly food is important, but the widely divergent grazing habits of livestock indicate that other factors are also at work, says range scientist Fred Provenza, who studies how grazing preferences are formed. His ultimate goal—to create a training regime for livestock so farmers and ranchers have more influence over what livestock eat and where they graze. This could, for example, include training livestock to avoid ecologically sensitive riparian areas.

So far, it appears that an animal's preferences or dislikes for certain foods outweigh social influences (the actions of other livestock). Access to water doesn't appear to be that important, which means that livestock probably aren't hanging around streambanks because they want to stay close to drinking water. That should mean that they can be trained to linger elsewhere.

"It's often assumed that the location of salt changes the

Another problem—certain varieties of wheat inhibit the expression of apomixis.

This type of science places a premium on patience and persistence

Wang estimates that his associates have made hundreds of crosses and more than 10,000 pollinations in order to get a few wheat-wheatgrass hybrids. The fledgling plantlets require coddling via a process known as embryo rescue, which is necessary because the endosperm that nourishes the developing embryo usually doesn't develop in seeds that give rise to the true hybrid. Embryos are rescued by removing them from the germinating seed and placing them in a nutrient-rich, hormone-balanced medium that duplicates the environment in the seed.

"Probably 1 in 500 of these embryos survives. And of those that germinate, some are albino or develop only roots or shoots. It's very difficult to cross wheat and Australian wheatgrass," Wang says.

dispersion of livestock, but no one has determined whether this is true," Provenza says. The salt requirements of livestock vary throughout the year, and so might their attraction to salt. Their attraction to protein supplements and other nutrients also changes, and might also be used to guide livestock dispersal.

In any event, the habitat preferences of livestock aren't acquired willy-nilly. There's logic behind their actions. It's up to researchers to find out what it is so they can capitalize on it.

The chromosomes in any healthy green wheat-wheatgrass plantlets are checked to make sure that the hybrid contains all of the wheat chromosomes. Cell division is also checked during meiosis to determine if em-

TRAILS OR TRAILERS?

For years, sheep producers in Sanpete County have grazed their flocks on private land early in the spring before moving them over trails to allotments on the Manti-LaSal National Forest. Or rather, they did until the U.S. Forest Service determined that sheep trampled wet areas around snowbanks, and required ranchers to either delay moving sheep for two to four weeks or to truck them to grazing allotments.

USU economist Darwin Nielsen and Extension livestock specialist Nyle Matthews helped ranchers weigh the advantages and disadvantages of each option.

It turns out that trucking costs about as much as leasing private land for two weeks. (However, it's doubtful whether ranchers will find land to lease during that period.) If done properly, trucking didn't seem to appreciably increase mortality or injury to sheep.

bryos reproduce sexually or via apomixis. Embryos with the genes for sexual reproduction form four cells, one of which develops into a normal egg, while those with the genes for apomixis form two cells, one of which develops into a egg that contains the full complement of chromosomes.

Other factors may be important, even though they weren't included in the economic analysis, Nielsen says. For example, there's the risk of overgrazing if sheep are kept on private land for an additional two weeks. Herding sheep to and from locations may keep sheep on trails longer than if they were herded to grazing allotments. The new Forest Service policy may also increase the consumption of fossil fuels.

In any case, the findings have helped ranchers choose which option makes the best economic sense, which helps them stay in business.

KG Nyle Matthews
 896-9262
 Darwin Nielsen
 750-2321

The hybrid has been backcrossed twice, but researchers are still trying to develop a breeding scheme that's compatible with apomixis.

Crossing sexual and apomictic strains of Australian wheatgrass may let them ferret out the apomixis genes. "The hybrid is sterile, but pairing between the chromosomes is nearly perfect. These species have the same genomic constitution, but there's just enough chromosome rearrangement to result in sterility," Wang says. The apomictic genes in the hybrids segregate when they are backcrossed, letting researchers determine which molecular markers are associated with apomixis.

"It will probably take 2 years to identify the genes associated with apomixis. Once these markers are

Please turn to page 123

Learning How to Change Leaf Growth Rate

What limits the growth rate of the leaves of plants?

Grasses are an ideal experimental system to find out. In grasses, cell growth occurs at the bottom of the leaf and displaces more mature cells toward the leaf tip, creating rows of cells from the bottom to the top of each blade. By comparing cells that are still growing with their relatives farther along the same leaf blade that have stopped growing, USU plant physiologist Jennifer MacAdam can identify the process that determines the rate of leaf growth, information that may be the key to increasing production of forages and other crops.

The walls of plant cells contain a "skeleton" of cellulose fibers that are coated with hemicelluloses. As cell walls grow and expand during growth, these fibers change position by sliding past one another. One theory attributes the cessation in growth to the inability of these fibers to slip past each other.

Hemicelluloses, long thin molecules that lie along the rod-like cellulose fibers, contain side chains that extend into the gel-like matrix that makes up the rest of the wall. These side chains contain phenolic acid molecules that may halt growth of a plant cell when they bond to each other.

MacAdam is measuring levels of peroxidase, the enzyme that binds phenolic acid molecules, to determine whether this view of leaf growth is accurate. So far, her findings have supported the theory. Peroxidase activity in cell walls in the region of grass leaves where growth has stopped was much higher than the cells on either side, which were younger or older. Moreover, the level of phenolic acids in cell walls also increased as cells reached the region where growth stops.

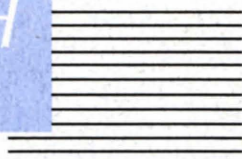
She also plans to determine whether linkages between phenolic acids increase in non-growing cells, which would further confirm the relationship between hemicellulose cross-linking and cessation of cell growth.

Identifying the mechanisms that determine the rate of leaf growth could eventually help scientists produce grain crops that complete their vegetative growth more rapidly, leaving more time for seed fill, forages that could be harvested more often, or perhaps slowing turfgrass growth so lawnmowers aren't necessary.

This research is supported by mineral lease funds.

KG

Jennifer MacAdam 750-2364



New Kaysville Orchard Aids Fruit Research

The 60-acre research and demonstration orchard in Kaysville serves as a living laboratory for fruit production.

The orchard was funded in 1990 by the Utah Agricultural Experiment Station and Utah Cooperative Extension Service. The orchard includes Montmorency tart cherries, Bartlett and d'Anjou pears, Suncrest peaches, six varieties of apples and a lot of research.

Some of this research concerns the effects of ground covers and cultivation methods on pest management, tree growth, water use efficiency and reflective UV radiation. The ground covers are alfalfa, grasses, clover and weeds. Bare ground is either cultivated or treated with herbicides.

"In a natural environment there would be diverse vegetation that would also attract beneficial insects such as parasites and predators," says entomologist Diane Alston.

Much of her work concerns spider mites, a "secondary pest" that doesn't directly attack fruit but can damage foliage. Spider mites thrive in Utah's hot, arid environment.

On bare orchard floors, spider mite populations can reach economically damaging levels, in part because they overwinter near the base of trees and later move into trees in search of food. Plots with

alfalfa, subclover or weed cover can attract significantly more beneficials, thereby keeping mite populations down, Alston says.

Ground covers affect the moisture that's available to trees. Ground covers compete with trees for water but also hold moisture in the soil and help prevent runoff. Horticulture specialist Tony Hatch is measuring water use with neutron probes to determine how ground covers affect water use and to optimize irrigation scheduling.

Hatch also studies pruning systems and tree training designs at Kaysville. One aspect of his research involve aggressive pruning of tart cherry trees, which results in larger, better quality fruit that may be more profitable than traditional pruning methods, which result in high yields of small fruit.

Researchers will install radiometers in the orchard in 1993 to measure incoming and reflected UV rays to determine if ground covers influence the uniformity of maturity in fruit crops, and whether they reduce sunburn damage to apples.

Plant pathologist Sherman Thomson studies fire blight, a bacterial disease of pears and apples. He found that the popular new apple varieties Gala, Mutzu and Prime Gold are more susceptible to fire blight and powdery mildew than are the red delicious varieties.

Alston says the traps containing synthetic codling moth pheromone—a chemical produced by female codling moths to attract males—that are used to monitor moth populations also confuses male codling moths and prevents them from mating. These pheromones may have a role in an integrated pest management program.

LH

Diane Alston 750-2516
Tony Hatch 370-8471
Sherman Thomson 750-3406

Study Assesses Economic Clout of Utah's "Green Industry"

Utahns' interest in keeping the landscape green also greens up the state's economy.

According to a recent study, households in Utah spend more than \$735 million annually on products and services related to the horticulture-greenhouse industry in the state. Large users of "green industry" goods and services—which include plants, hardware, landscaping and lawn care services—spent at least \$10 million annually.

The total expenditures of green industry goods and services of nearly three quarters of a billion dollars generate more than 17,600 full time equivalent workers and a payroll of nearly \$350 million, says economist Don Snyder, who conducted the study with graduate student Richard Wilde.

The average household spends more than \$1,700 on green industry products and services annually, including more than \$700 for landscaping and almost \$250 for tools and power equipment. Surroundings apparently got greener when people owned their homes. Owner-occupied households spent about twice as much for green industry products and services as did renter-occupied households.

The study involved four surveys—two involving producers of green industry products and services

(greenhouse-horticulture firms and large retail stores) and two involving purchasers of these goods and services (households and large users, such as schools and government agencies).

Copies of the Research Report 144, *The Economic Impact of Utah's Green Industry*, are available from Don Snyder, Economics Department, Utah State University, Logan, UT 84322-3530.

KG

Donald Snyder 750-2305

New Faculty

Jeanette M. Norton joins the Plant, Soils & Biometeorology Department as an assistant professor of soil microbiology. She earned a BS degree from the State University of New York, Syracuse, and PhD in soil microbiology from the University of California, Berkeley. She was previously research associate, with the Center for Microbial Ecology at Michigan State University.

Dani Or is soil physicist with the Department of Plant, Soils & Biometeorology. He earned BS and MS degrees from the Hebrew University of Jerusalem (Israel) and a PhD at USU. He was previously employed at the Department of Civil Engineering at the University of California, Berkeley.

Ann W. Sorenson is professor and head, Nutrition & Food Sciences Department. Sorenson earned BS and MS degrees from the University of Utah and a PhD in nutrition and food science from USU. She was an administrator with the National Institute on Aging, National Institutes of Health.

Recent Grants & Contracts

The Church of Jesus Christ of Latter-day Saints Foundation supports the research of **Ann Austin**, Family and Human Development Department, concerning home day care training programs.

John Stark, Biology Department, is studying the microbial assimilation of nitrate and nitrogen loss from forest ecosystems with a grant from the Cooperative State Research Service (USDA).

Noelle Muggli-Cockett and **Thomas Bunch**, Animal, Dairy & Veterinary Sciences Department, are isolating the genetic marker that segregates with the spider lamb syndrome gene. Their research is supported by the Cooperative State Research Service (USDA).

William Varga, Plant, Soils & Biometeorology Department, is studying water-saving techniques. His research is funded by the Bureau of Reclamation, US Department of the Interior.

The Utah Energy Office is supporting efforts to improve the energy efficiency of housing. The research is conducted by **Stephen Poe**, Agricultural Systems Technology & Education Department.

Gilbert Long, Agricultural Systems Technology & Education Department, is studying the sustainable agriculture practices utilized by Utah farmers. The research is supported by the Utah Department of Agriculture.

Diane Alston, Biology Department, is developing a resistance management program for the onion thrips in Utah dry bulb onion production with support from the Cooperative State Research Service (USDA) Western Region Pesticide Impact Assessment Program

Paul Savello, Nutrition & Food Sciences Department, has received funding from the National Dairy Promotion and Research Board for research projects in the Western Dairy Foods Research Center.

Frank Messina, Biology Department, is studying the biology and floral fidelity of *Perdita meconis*, a pollinator of a rare plant, with support from the Agricultural Research Service (USDA).

Mark Healey, Animal, Dairy & Veterinary Sciences Department, is studying cryptosporidiosis with support from CIBA-Geigy.

Philip Rasmussen, Agricultural Systems Technology & Education Department, is studying forages that will compete with cheatgrass and other undesirable vegetation, thus reducing the fire threat along highway right-of-ways. The study is funded by the Bureau of Land Management. The University of

California-Davis also supports his effort to develop a Hypertext database for sustainable agriculture.

DeeVon Bailey, Economics Department, is defining relevant market areas for buyers and sellers of feeder cattle. His research is supported by Virginia Polytechnic Institute.

David Hole, **Rulon Albrechtsen** and **John Carman**, Plants, Soils & Biometeorology Department, are breeding resistant varieties of wheat to control dwarf bunt (TCK). The work is supported by the Cooperative State Research Service (USDA).

Jon Takemoto, Biology Department, is collaborating in the synthesis of hemin derivatives. The research is funded by the Meiji Milk Products Co., Ltd. (Japan).

The Utah Department of Agriculture supports the development of new added-value lamb products by **Von Mendenhall**, Nutrition & Food Sciences Department.

PEAS SHOW PROMISE AS PROTEIN SUPPLEMENT

Continued from page 118

found, we can then use them to screen wheat-wheatgrass progeny to select plants that carry the genes for apomixis," Wang says.

"We knew it would be difficult when we started. There were indications that apomixis in the Australian wheatgrass is facultative, which means that apomixis can be partially expressed, depending on environmental conditions," Wang says. This partial expression of apomixis makes selection more difficult, but can aid breeding once apomictic genes are tagged.

Wang says researchers working with some other crops are making more progress in identifying the molecular markers associated with apomixis. If they do find these markers, USU researchers may use them to locate the apomixis gene in wheatgrass. It may be possible to import the apomixis genes into wheat from another crop.

KG

Dry peas are an acceptable protein supplement for livestock rations. Growing them in Utah would let Utah farmers capture income now spent on imported soybean meal.

Miranda, a variety that USU researchers have studied for several years, has gained a foothold in the state, both among livestock producers and growers. However, weed control early in the season is a problem, in large part because young pea plants grow slowly and let weeds get a head start. The problem is compounded by a lack of effective herbicides.

USU agronomist Ralph Whitesides is studying several other varieties of peas that may be even better than Miranda, including some that are popular in Europe. These varieties seem to compete with weeds more aggressively. Whitesides and graduate student

Marlon Winger will also determine how herbicides approved for use on peas are affected by the soils in Utah, where soils tend to be more alkaline and contain less organic matter than areas where these herbicides are usually used.

So far, the results are promising. Even when weeds were a problem, some of these varieties yielded more than 3,000 pounds per acre, more than the 2,000 pounds per acre that economists in other states have identified as the break-even point.

KG

Ralph Whitesides
750-2259

John Carman 750-2238
Richard Wang 750-3222

SALVAGING ADULTERATED MILK

According to regulations, every tanker of Grade A milk must be tested for antibiotics and any contaminated loads can either be discarded or antibiotics can be removed and the milk can be used for some non-Grade A purpose.

There's just one catch—no one knows how to remove antibiotics from milk.

USU food scientist Bart Weimer is testing a method that might extract beta-lactam antibiotics, which include penicillin, amoxicillin, ampicillin and cloxacillin, from contaminated milk.

Weimer plans to attach anti-penicillin antibodies to glass, ceramic and magnetic beads. As the marble-sized beads move through the milk, the antibodies bind the antibiotics, which are then removed with the beads. The beads can be reused after they are treated to release the antibiotics.

"Adulterated milk was once sold to farmers for animal feed but this isn't allowed anymore. However, reconditioned milk could be used for animal feed and perhaps for some types of cheese making," Weimer says.

Penalties vary, but a dairy that produces contaminated

milk must pay for disposal costs, which may involve fees of hundreds of dollars for disposal at a toxic waste-handling facility. Offending producers must also complete a 30-day quality assurance program, are prohibited from selling milk for two days and must reimburse others whose milk was in the contaminated load.

That's just for a first offense.

As of July 1, 1992, test results must be reported to a state regulatory agency. If these stiffer regulations had been in effect during the first five months of 1992, 12 Grade A permits in Utah would have been suspended and 363,500 pounds of milk worth \$63,950 would have been dumped.

Weimer says the best solution is to use antibiotics properly. However, reconditioning this milk could reduce some of the losses.

LH Bart Weimer 750-3356

90 percent of the wheat kernels in a field and transforming kernels into a smutty ball of spores. Wheat has some resistance, but it's derived from a single gene, which isn't very much, considering dwarf smut's ability to develop new virulent forms. Barley and rye are strongly resistant to dwarf smut and derive their resistance from several genes. Transferring those genes to wheat would let wheat breeders draw on a much greater pool of resistance.

"Rye has seven chromosomes, two or three of which seem to be associated with resistance to dwarf smut," says USU wheat breeder David Hole who is trying to transfer the resistance genes from barley and rye to wheat. He has screened several lines of wheat that carry one or a partial chromosome from rye (addition lines). After

Better Resistance Against Dwarf Smut

For six decades, plant breeders have been able to keep—barely—one step ahead of dwarf smut by breeding resistant varieties of wheat. They're now trying to tap better sources of resistance from rye and barley.

Dwarf smut (*Tilletia contraversa*) is a fungus whose spore can linger in the soil for years, poised to infect more than

repeated crosses with wheat and other addition lines, the rye genes that confer resistance should segregate. Mutagenic chemical and radiation treatments that encourage chromosome breaks will then be used to append these genes to wheat chromosomes.

If all goes well, Hole expects that varieties of wheat could carry potent sources of resistance to dwarf smut in 5-7 years.

KG

David Hole 750-2235

Taming Range Grasses to Create Better Turf Grasses

As a breeder of range grasses, Kay Asay didn't think that the short crested wheatgrasses with fine leaves that spread by rhizomes held much promise for livestock.

He was right about the livestock.

He was wrong about the promise.

The accessions from Turkey, Iran and other areas in the region may not appeal to livestock but the plants that Asay, a research plant geneticist with the Forage and Range Research Laboratory, almost ignored what may be one of the biggest discoveries of his career—drought-resistant crested wheatgrass that's suitable for turf.

A BETTER METHOD OF INSPECTING HAY FOR WEEDS

In an effort to curb the spread of noxious weeds, the U.S. Forest Service now requires that hay brought onto land under its jurisdiction be certified as weed-free. It's not an insurmountable requirement, but it's expensive and time consuming to inspect hay shortly before harvest, the only way to meet the standards for certification.

There may be a better way.

USU agronomist Ralph Whitesides and Dave Clark, research scientist with the Agricultural Research Service, are determining whether near infrared reflectance spectroscopy (NIRS), a method that is widely used to analyze feedstuffs, can also determine whether hay is weed-free. If so, analyzing core samples from bales could determine whether they contain weeds, and perhaps even identify the types of weeds.

The study also involves Steve Dewey, Extension weed specialist.

KG

Ralph Whitesides
750-2259

The discovery comes just in time. Americans still lavish time and money on their lawns but pollution regulations may curtail fume-spewing lawnmowers and water shortages may put thirsty, rapidly growing turfgrasses on the endangered list.

Commercial varieties of the new turfgrasses that require about half as much water (and less mowing) as conventional lawn grasses should be available in about three years. Asay has studied the turfgrasses for almost 10 years and is now determining how often grass should be watered, cut and fertilized.

There's big money in turf. Some analysts estimate that the annual demand for new turf grasses could generate more than \$200 million annually.

KG

Kay Asay 750-3069

Removing a Biotech Bottleneck

In some respects, the current situation in biotechnology is similar to that faced by the nascent automobile industry—it's not enough to produce a better product, whether a Ford or a genetically engineered plant, unless you can do it economically.

The ability to transform individual cells has outpaced the ability to regenerate these cells. "It's relatively easy to transform individual cells but it's difficult to get

them to develop into a plant. Today's bottleneck in the genetic engineering of cereals involves somatic embryogenesis," says USU plant scientist John Carman, referring to the process by which genetically transformed plant cells may develop into full-fledged plants.

The odds certainly aren't in our favor. If, for example, researchers can successfully transform 1 in 5,000 cells, and only 1 in 100,000 or so of those cells develops into a plant, genetic progress would be exorbitantly costly and pitifully slow.

Carman is improving these odds by making sure that the conditions in tissue culture duplicate the environment in the seed. So far, it seems to work. Including oxygen tensions at levels found in developing wheat kernels increased somatic embryogenesis of wheat callus by 10-fold.

Other factors that he is studying—plant hormones (auxins, cytokinins and abscisic acid), sugars (monosaccharides, disaccharides and trisaccharides), and minerals—may result in similar gains.

KG

John Carman 750-2238

DETERMINING WATER USE IN CROPS

How does climate affect a crop's water requirements?

Obviously plants use more water when it's windy and warm, for example, but there's much more to learn about the relationship between the various aspects of climate and evapotranspiration. Esmail Malek, USU biometeorologist has been monitoring factors such as wind speed, solar radiation, and air and crop temperatures at several locations every 20 minutes for more than 5 years to determine how they affect the loss of water through stomata in alfalfa leaves, a phenomenon known as crop canopy resistance.

Canopy resistance is high when stomata are closed and is low when stomata are open.

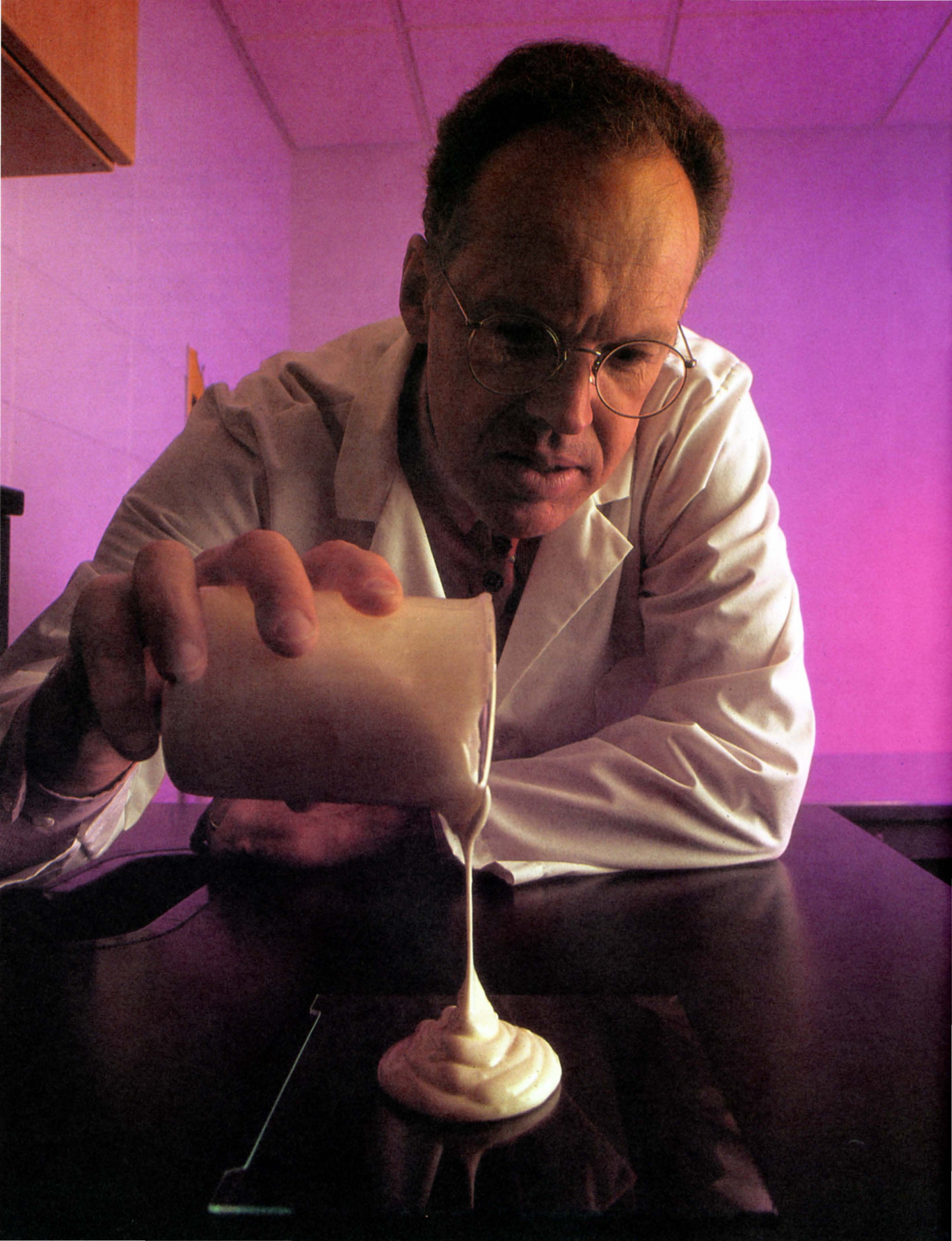
"This is the first time these climatic factors have been measured continuously

throughout the growing season," Malek says. Of particular interest was how evaporation changed during the course of the day and during the night.

Among other findings, Malek found that alfalfa canopy resistance tended to vary indirectly with solar or net radiation and soil moisture, but it made a difference where the soil heat flux (radiation per unit time per unit area) was measured. To calculate evapotranspiration in the short term, it's best to use heat flux at the soil surface. Over a 24-hour period, however, it didn't make much difference whether heat flux was measured at the soil surface or a few inches below the soil surface.

Findings will be useful in locating solar collectors, irrigation management and selecting crop varieties.

KG Esmail Malek 750-3284



Helping the Dairy Industry Gear Up for the Next Century

If we were designing enterprises for the nineties, we could do far worse than investing in dairy cows. They are paragons of productivity. All natural. What they produce (and what they are) is largely recyclable (and what can't be recycled is biodegradable).

As with many things in life, our opinions are colored by our point of view. Some people see the dairy industry mired in a surplus of milk. Paul Savello has a different perspective. He sees an industry in which productivity has temporarily outdistanced innovation.

As director of USU's Center for Dairy Foods Technology, Savello sees the light at the end of the tunnel, and it's not the proverbial train but the glow of new ideas. Milk is a raw material as versatile and valuable as petroleum, he says. It is a commodity whose merits haven't yet been fully plumbed.

There's considerable evidence to back his belief, particularly in view of the research underway in the center, which focuses on membrane processing of milk and the ultra-high temperature (UHT) processing of milk and milk products.

Photo: Paul Savello examining shelf stable, non-refrigerated concentrated milk.

MUNICIPAL COMPOST HEAPS

Yard and garden "waste" isn't garbage, but it's often treated that way. It makes up about 18 percent of the landfills in America and about 25 percent of the landfills in Utah.

That's too much, and many municipalities and special service districts are trying to stanch the flow by composting grass clippings, pruned branches, leaves and vines. New landfill regulations from the Environmental Protection Agency require a 25 percent reduction in the amount of material hauled to landfills.

Unfortunately, this, low-tech effective approach is threatened by regulations designed to prevent harmful chemicals from leaching into the ground or surface water.

These regulations may require municipalities to install six-inch concrete pads, asphalt pads, or clay or plastic liners under compost heaps.

The precautions may not be necessary, says USU agricultural and environmental engineer Kitt Farrell-Poe, who is examining the amounts and movement of potentially harmful chemicals in municipal compost heaps. Of particular concern is the threat posed by nitrate-containing products and pesticides like 2,4-D and Diazanone, which are commonly used in landscape maintenance, especially

when the yard and garden waste is composted with municipal waste sludge, which concentrates heavy metals.

Nonetheless, Farrell-Poe thinks foliage and chippings contain few of these chemicals by the time material is added to a compost pile. Moreover, there is probably little downward movement of water in compost piles, particularly in Utah's arid environment. "Compost is not irrigated and most places that do compost in Utah only turn the piles a couple of times each year.

"We should save our landfills for items that can't be recycled, reused or composted," she says. Her research may help us reach that goal.

LH Kitt Farrell-Poe 750-3389

One milk-processing technique employs a series of membranes to concentrate milk to one-third its original volume. The process requires much less energy than the conventional method of evaporation.

A Logan firm, NutriScience, combines this method of membrane processing with UHT treatment, producing a concentrated milk that remains stable for as long as a year, without refrigeration. The concentrated milk shaves transportation costs, an attribute which should spur exports. Simply adding water to the concentrate results in milk that tastes as good as fresh.

A patent is also in the works for a processing method that gives skim milk a creamier mouthfeel, one comparable to 2 percent milk.

UHT processing and membrane concentration have also been used to produce a shelf-stable, soft cheese that requires no refrigeration. Researchers also continue to refine the manufacturing processes used to produce a pourable cream cheese. "We can vary the manufacturing parameters so the texture of baked products varies from creamy and smooth to open and porous," Savello says.

One important function of the center is to help these ideas percolate through industry. "We don't just develop the process or concept but help companies utilize the expertise and equipment available at the center," Savello says. "Several firms have used our facilities and then contracted with local firms for additional studies. This has accelerated research and development, and the commercialization of our findings."

Companies have access to several types of pilot plants in the department, many involving equipment and processes that would otherwise be available only in much larger plants, and at considerable expense.

Dairy-related ideas keep flowing from several sources, including the Western Dairy Foods Research Center that is also located in the Nutrition and Food Sciences Department. This center, one of six in the U.S., is supported by the National Dairy Promotion and Research Board, by dairymen in Oregon, Idaho and Utah, and by dairy manufacturing firms.

Research in the Western Center addresses a wider range of topics than the state-funded center, and includes starter cultures, nutrition, membrane processing, thermal processing and the utilization of whey. (See the Winter 1991 issue for an

A SATELLITE SYSTEM THAT DELIVERS

USU is a major contributor to—and a beneficiary of—AG*SAT, the satellite system that links 42 land-grant universities around the United States. This spring, AG*SAT programs will be received in all Utah counties.

More than 200 cooperative extension programs and 11 academic programs have already been carried over the system, says Weldon Sleight, associate dean for resident instruction with the USU College of Agriculture. That's only the start.

USU horticulturalists Larry Rupp and Roger Kjellgren are teaching Landscape Management in the Interior West over the AG*SAT system. USU has also developed courses in animal breeding and in irrigation, and faculty members are helping develop a seven-course sequence in bioengineering and a course in international

agribusiness trade and marketing.

Extension will offer several modules on international marketing. "It's clear that we could expand markets for many agricultural commodities. The future for many of these commodities is in developing markets abroad," Sleight says.

Also on tap—a masters degree program for extension agents, courses on food technology, and several cooperative extension programs. "AG*SAT will be a major factor in the revitalization of rural America," Sleight says.

County extension offices have information about the programs offered by AG*SAT.

KG Weldon Sleight
750-2214

GOOD ANIMAL CARE FOR GOOD RESEARCH

Their diets are balanced, the water is fresh, the air is fresh, cages are cleaned twice a week, and temperatures are always comfortable. Emergency generators keep things humming if the supply of electricity is interrupted. A security system keeps out unauthorized visitors.

These are good accommodations, good enough for thoroughbred horses or endangered animals—and for the menagerie of mice, chickens, voles, guinea pigs, pigeons rabbits, rats, hamsters and other animals that inhabit USU's Laboratory Animal Research Center (LARC).

These animals are vital in research encompassing areas such as behavior, toxicology, genetics, virology, says and many other studies LARC Director and attending veterinarian Stanley Allen.

"There are certain questions related to animal and human health that can't be answered without studying live animals," Allen says. He says these animals are treated with great care not only because "it's the right thing to do," but because rearing animals in an optimal environment improves the quality of research, making it possible to detect slight variations related to various treatments.

"Things like animal weight are often very important. Researchers can't guess whether an animal lost a few grams because of a virus infection or because it wasn't fed properly," Allen says.

Allen is executive secretary of the university's Institutional Animal Care and Use Committee (IACUC), which reviews all research proposals involving animals and visits all USU animal research sites twice annually and monitors compliance with the regulations in a hefty volume titled "Care and Use of Agricultural Animals in Agricultural Research and Teaching." Other regulations apply to wildlife research. Committee members also monitor compliance with the Animal Welfare Act and regulations from the National Institutes of Health.

Each year the staff at LARC, and its satellite facility in the Biotechnology building, care for an average of 10,000 mice, 20 rabbits, 10 guinea pigs, 15 hamsters and other species. These animals used in studies ranging from how fungal treatments on plants might effect wild bird populations to how our immune system fights infection.

LH Stanley Allen 750-1900

It's certainly seems possible. And the results will have a pleasant taste for consumers, and for the dairy industry.

KG

article about research at the center.) New research in this center addresses the extraction of antibodies from milk for medical and pharmaceutical applications, improving the melting properties of Mozzarella cheese, producing iron-fortified yogurt, preventing gelation in UHT-processed milk concentrates, and increasing the use of milk caseins in other foods.

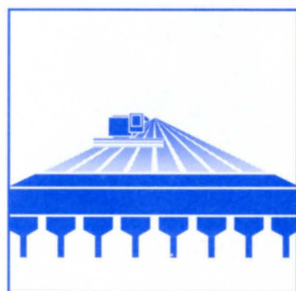
A recent spinoff is the creation of the Western Center for Dairy Protein Research. The new unit is primarily concerned with low-fat cheeses, especially their flavors, which tend to be less pronounced than those that contain more fat.

The dairy industry has been awash in surplus milk for several decades and nothing—not even low prices, herd buyouts, droughts or floods—seems to stem the flow. Perhaps new ideas generated at the USU centers will mean that the demand for milk eventually dwarfs the supply.

Paul Savello 750-3618

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